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(54) **WIDEBAND BOW TIE ANTENNA**

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(51) **Int. Cl.**

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H01Q 19/10	(2006.01)
H01Q 9/28	(2006.01)
H01Q 19/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H01Q 19/108*** (2013.01); ***H01Q 9/285*** (2013.01); ***H01Q 19/00*** (2013.01); ***H01Q 21/26*** (2013.01)

(58) **Field of Classification Search**

USPC .... 343/797, 700 MS, 702

See application file for complete search history.

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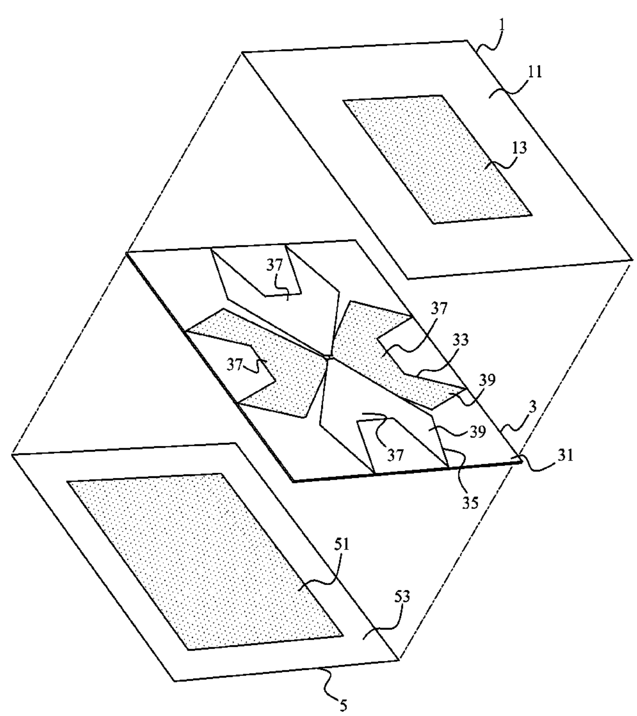
(57) **ABSTRACT**

A wideband bow tie antenna includes a guiding unit, a radiating unit, and a reflecting unit. The radiating unit is configured between the guiding unit and the reflecting unit. The radiating unit includes a guiding substrate and a guiding patch configured on the guiding substrate. The radiating unit includes a radiating substrate and a first bow tie radiator which is configured on the radiating substrate and coupled with the guiding patch. The first bow tie radiator includes two single radiating portions which are symmetrically configured to each other. The reflecting unit includes a reflecting substrate and a loop reflecting patch which are configured on the reflecting substrate and coupled with the first bow tie radiator.

5 Claims, 9 Drawing Sheets



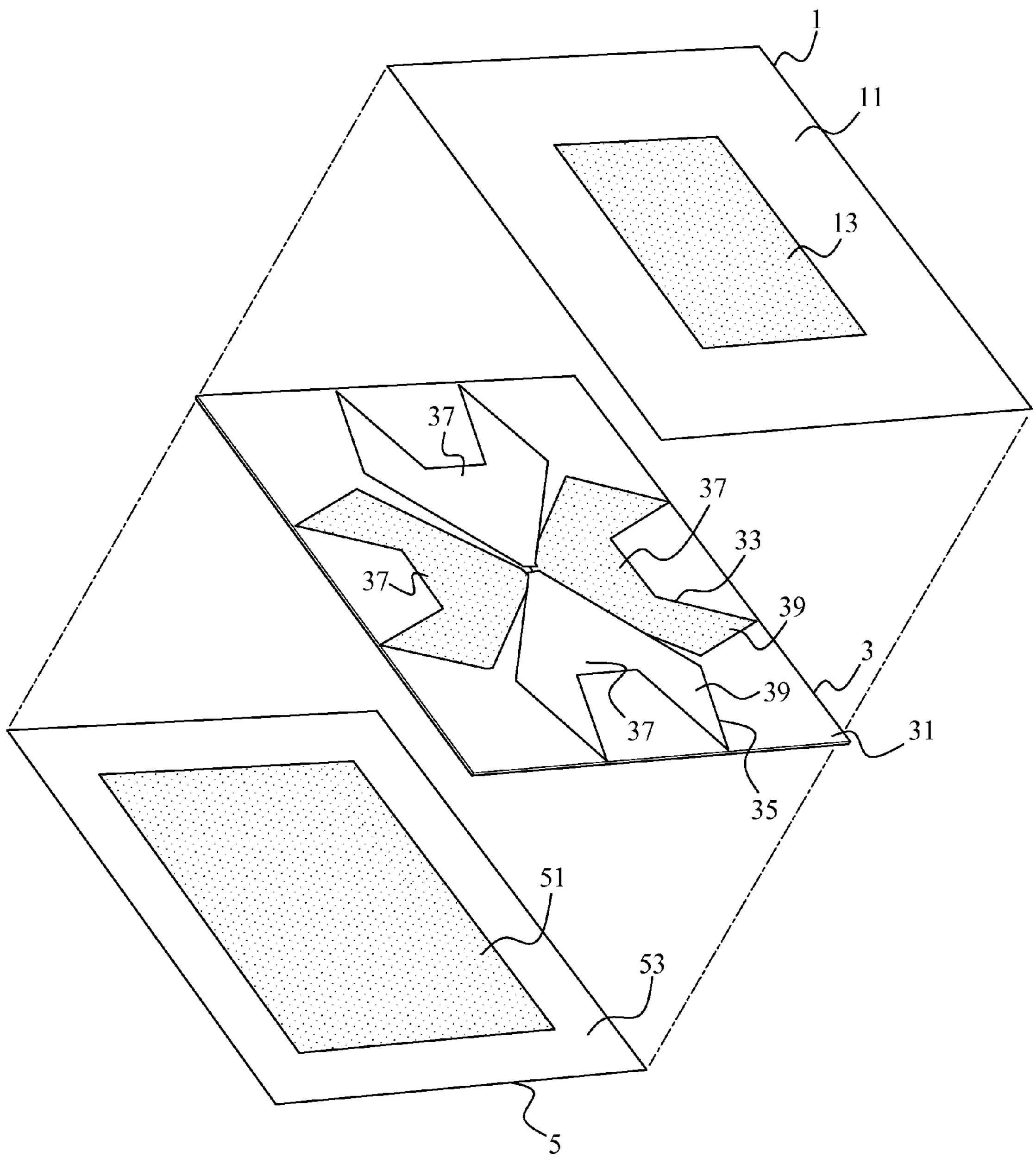


Fig. 1

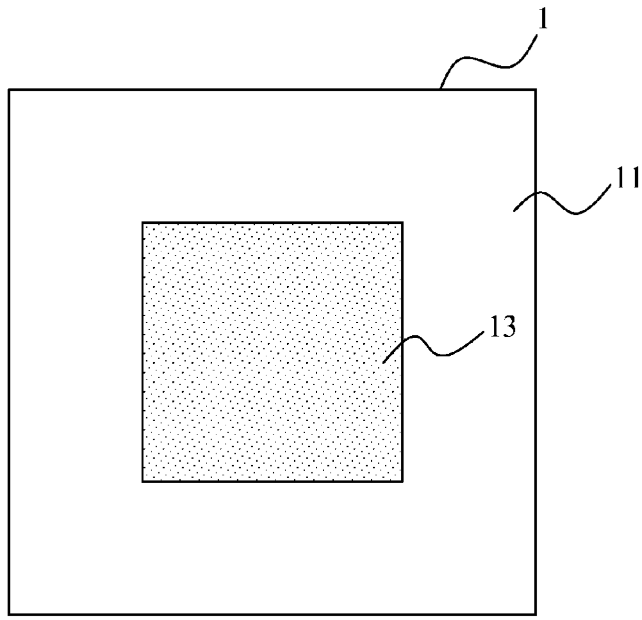


Fig. 2

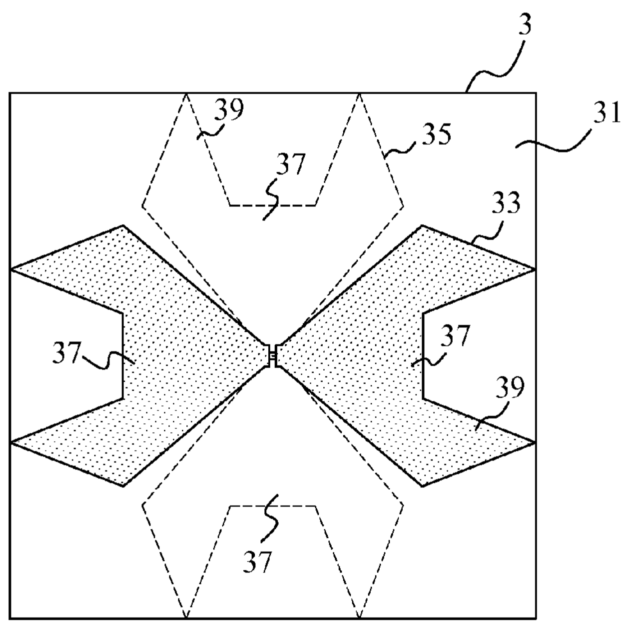


Fig. 3

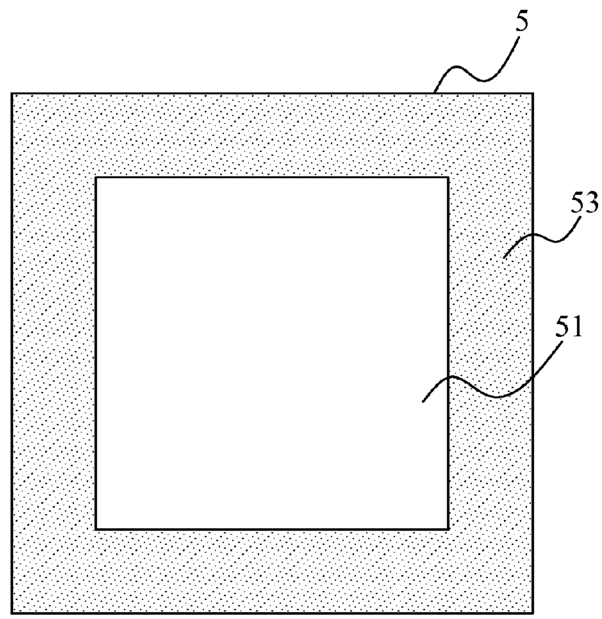

5
53
51

Fig. 4

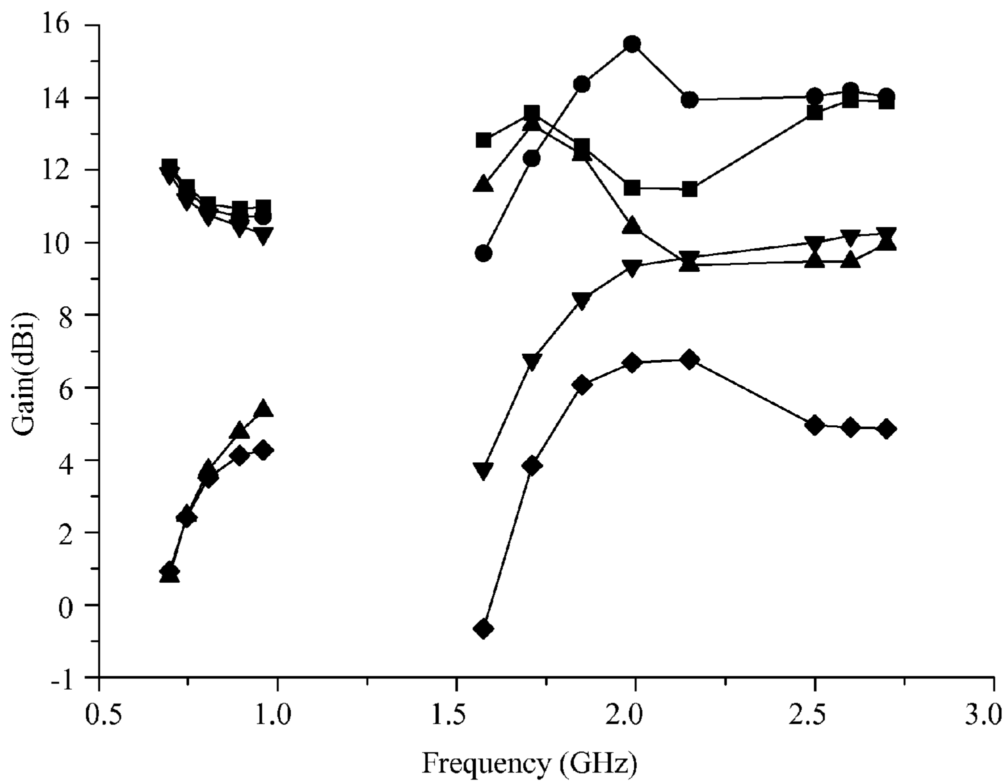

16
14
12
10
8
6
4
2
0
-1
Gain(dBi)
0.5
1.0
1.5
2.0
2.5
3.0
Frequency (GHz)

Fig. 5

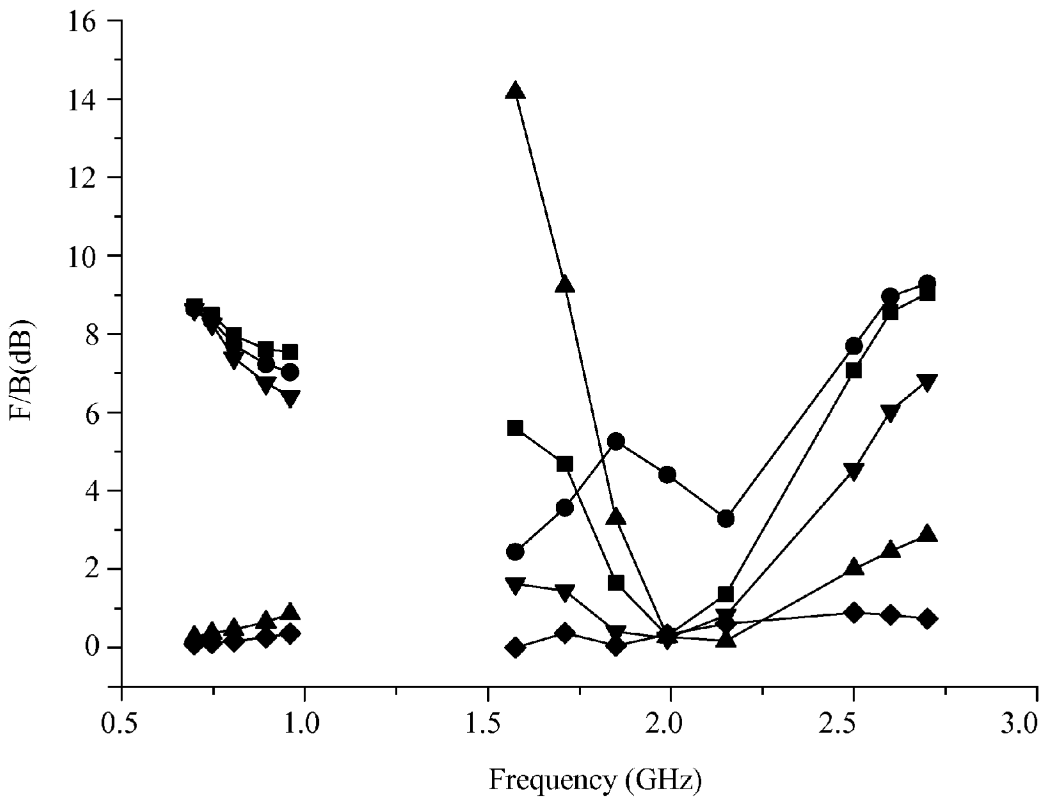
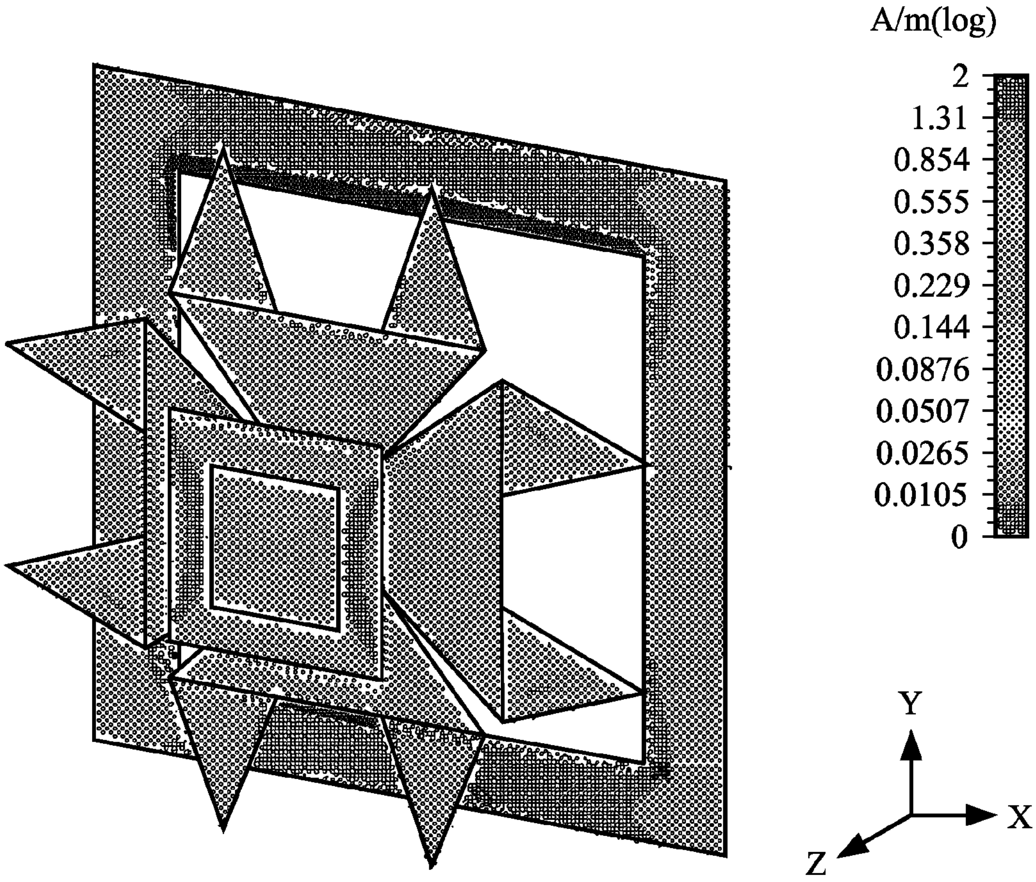


Fig. 6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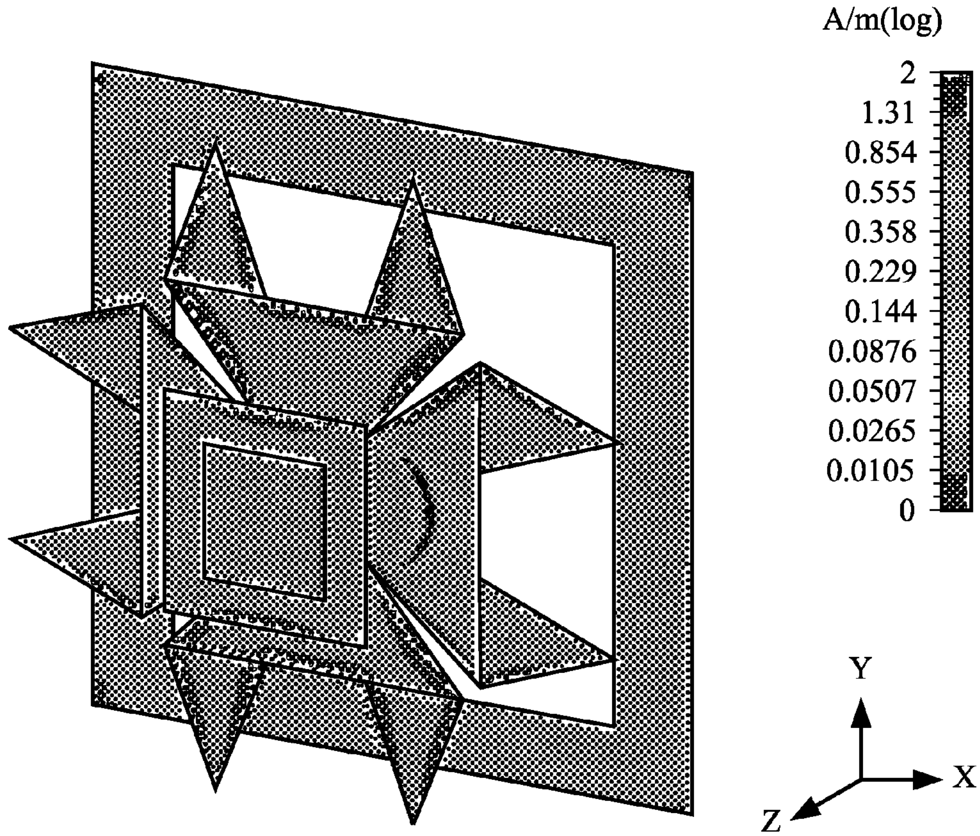
1.31
0.854
0.555
0.358
0.229
0.144
0.0876
0.0507
0.0265
0.0105
0
Y
X
Z

Fig. 7A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0.854
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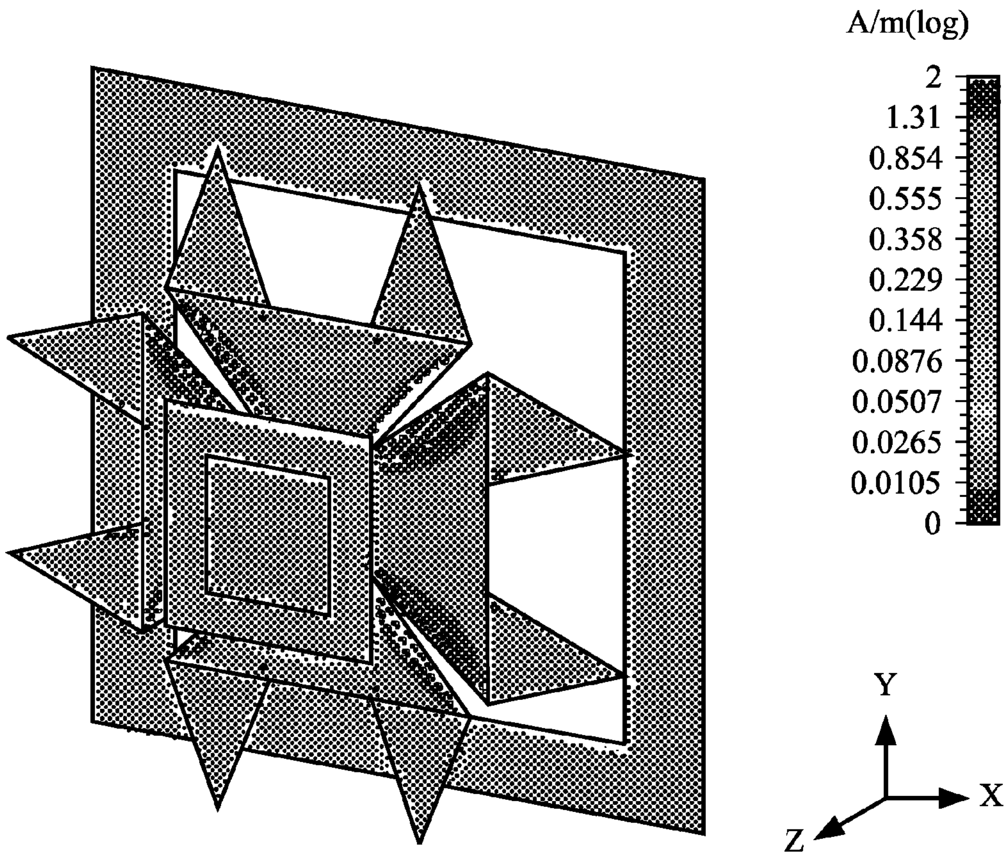
0
Y
X
Z

Fig. 7B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0.0265
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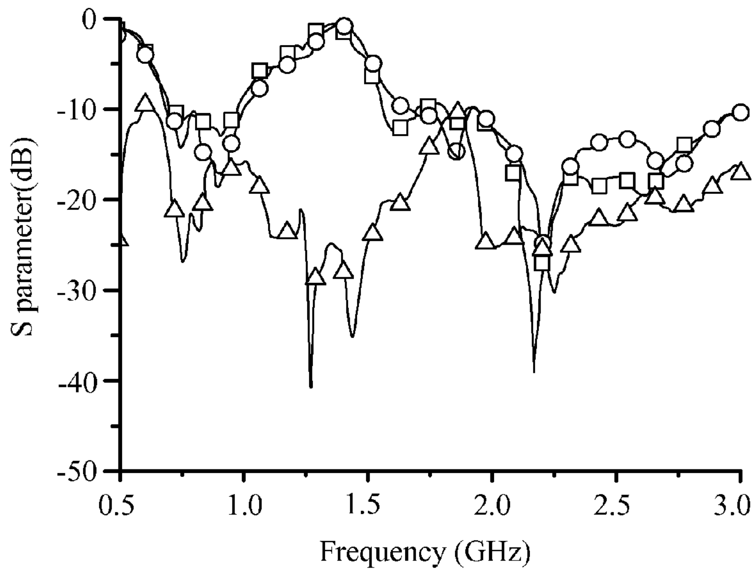
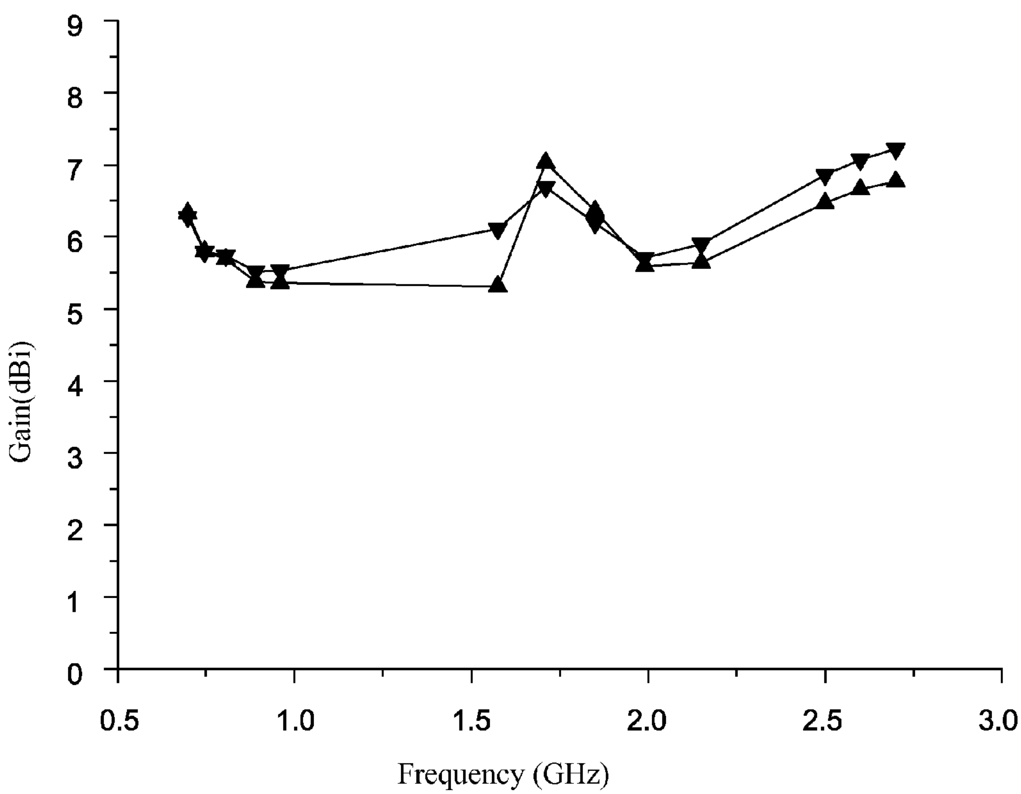
0
Y
X
Z

Fig. 7C



0
-10
-20
-30
-40
-50
S parameter(dB)
0.5
1.0
1.5
2.0
2.5
3.0
Frequency (GHz)

Fig. 8A



9
8
7
6
5
4
3
2
1
0
Gain(dBi)
0.5
1.0
1.5
2.0
2.5
3.0
Frequency (GHz)

Fig. 8B

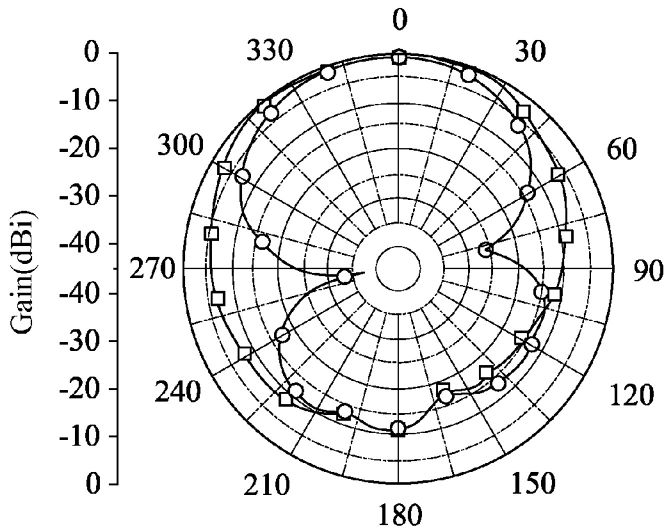

0
30
60
90
120
150
180
210
240
270
300
330
Gain(dBi)
0
-10
-20
-30
-40
-40
-30
-20
-10
0

Fig. 8C

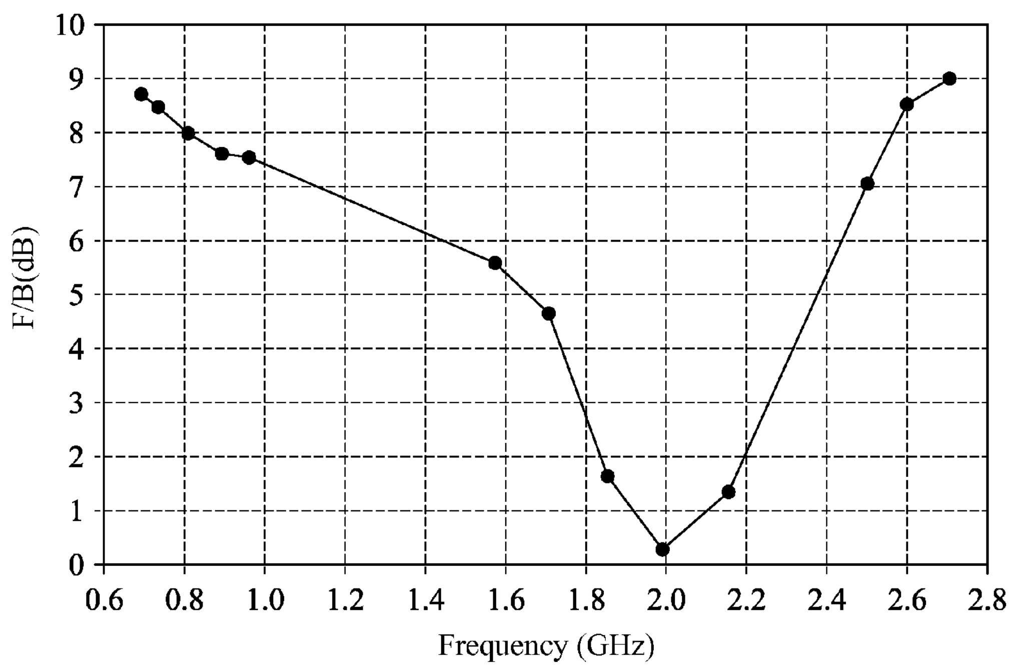

F/B(dB)
Frequency (GHz)
0
1
2
3
4
5
6
7
8
9
10
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8

Fig. 8D

WIDEBAND BOW TIE ANTENNA

FIELD OF THE INVENTION

The present invention is about a wideband bow tie antenna. More particularly, the present invention is about a wideband bow tie antenna applying a guiding unit and reflecting unit for improving wideband characters.

DESCRIPTION OF THE PRIOR ART

Nowadays wireless communication devices cover different spectrums to meet demands of multimedia wideband communication. Such as 2G/3G/4G wireless communication protocols, Wi-Fi, Global Position System (GPS), and etc. Each particular spectrum corresponds to a particular antenna for transmission. For the compact demands of size in wireless communication devices, a single antenna covering most communication bandwidths becomes a substantial technical issue.

Conventionally, a normal wideband antenna like bow tie antenna, monopole antenna, spiral antenna, and biconical antenna is omnidirectional antenna, and the gain is usually low. Besides, this kind of antenna, due to its omnidirectional character, is influenced when it is placed near a dielectric material without ground plane protection, and the radiation characters are influenced by the dielectric material. Thus, the antenna cannot meet default radiation demands.

For overcoming the previous problems, conventional technologies provided directional antenna such as log periodic antenna, Vivaldi antenna, and etc. However, the previous antennas only have monopole radiation pattern, which limits in receiving polarized electromagnetic waves from particular direction.

Therefore, the technical field needs wideband antenna for receiving dipole radiation pattern.

SUMMARY OF THE INVENTION

To solve the previous technical problems, one objective of the present invention is to provide a wideband bow tie antenna to solve problem of limited bandwidth of conventional antennas.

To achieve the aforementioned objective, the present invention provides a wideband bow tie antenna. The wideband bow tie antenna comprises a guiding unit, a radiating unit, and a reflecting unit. The guiding unit further comprises a guiding substrate, and a guiding patch being configured on a plane of the guiding substrate. The radiating unit is adjacent to the guiding unit, and the radiating unit further comprises a radiating substrate and a first bow tie radiator. The first bow tie radiator is configured on a plane of the radiating substrate and further coupled to the guiding patch. The first bow tie radiator further comprises two single radiating portions which are symmetrically configured to each other. The width of the each single radiating portion increases from the feeding end of the bow tie radiating portion to the end of the each single radiating portion. The reflecting unit is adjacent to the radiating unit, and the reflecting unit further comprises a reflecting substrate and a loop reflecting patch being configured on a plane of the reflecting substrate. The loop reflecting patch is further coupled with the first bow tie radiator. And the radiating unit is configured between the guiding unit and the reflecting unit.

Different from conventional Yagi antenna, wherein the guiding unit thereof is only able to enhance uni-direction

corresponding to mono polarized radiation wave, the guiding patch of the present invention is able to enhance direction corresponding to horizontal and vertical polarized radiation wave. And the loop reflecting patch is able to enhance direction of low-frequency radiation wave generated by the radiating unit. Comparing with the conventional antennas, the wideband bow tie antenna of the present invention is advantaged in good gain, and having the loop reflecting patch for reducing distance between the reflecting unit and the radiating unit. Thus, a more compact antenna with good gain performance is achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a wideband bow tie antenna diagram of the present invention;

FIG. **2** shows a guiding unit structure diagram of the wideband bow tie antenna of the present invention;

FIG. **3** shows a radiating unit structure diagram of the wideband antenna of the present invention;

FIG. **4** shows a reflecting unit structure diagram of the wideband bow tie antenna of the present invention;

FIG. **5** shows comparison diagram of gain/frequency of the wideband bow tie antenna of the present invention;

FIG. **6** shows a comparison diagram of front to back ratio (F/B)/frequency of the wideband bow tie antenna of the present invention;

FIG. **7**A shows current distribution diagram in low-frequency of the wideband bow tie antenna of the present invention;

FIG. **7**B shows current distribution diagram in mid-frequency of the wideband bow tie antenna of the present invention;

FIG. **7**C shows current distribution diagram in high-frequency of the wideband bow tie antenna of the present invention;

FIG. **8**A shows the S parameter diagram of the wideband bow tie antenna of the present invention;

FIG. **8**B shows gains of horizontal polarization and vertical polarization of the wideband bow tie antenna of the present invention;

FIG. **8**C shows 2D radiation diagram of the wideband bow tie antenna of the present invention; and

FIG. **8**D shows the F/B diagram of the wideband bow tie antenna of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is about embodiments of the present invention; however it is not intended to limit the scope of the present invention.

FIG. **1** shows a wideband bow tie antenna of the present invention. The wideband bow tie antenna comprises a guiding unit **1**, a radiating unit **3**, and a reflecting unit **5**. The guiding unit **1** is configured to enhance the direction of the wideband bow tie antenna. The guiding unit **1** further comprises a guiding substrate **11**, a guiding patch **13** configured on a plane of the guiding substrate **11**. The radiating unit **3** is adjacent to the guiding unit **1**. The radiating unit **3** further comprises a radiating substrate **31**, and a first bow tie radiator **33**. The first bow tie radiator **33** is configured on a plane of the radiating substrate **31**. The first bow tie radiator **33** is further coupled to the guiding patch **13**. The first bow tie radiator **33** further comprises two single radiating portions **37** which are symmetrically configured to each other according to the feeding end. The width of the each single radiating portion **37** increases from the feeding end of the bow tie radiating portion **37** to the end of the each single radiating portion **37**. By setting the size of the single radiating portion **37**, it is able to adjust impedance matching and radiation efficiency of the wideband bow tie antenna. The reflecting unit **5** is adjacent to the radiating unit **3**, and the radiating unit **3** is further configured between the guiding unit **1** and the reflecting unit **5**. The reflecting unit **5** further comprises a reflecting substrate **51** and a loop reflecting patch **53**. The loop reflecting patch **53** is configured on a plane of the reflecting substrate **51**, the loop reflecting patch **53** is further coupled with the first bow tie radiator **33**.

The aforementioned guiding patch **13**, the first bow tie radiator **33**, and the loop reflecting patch **53** are made of good conductor materials, such as copper or aluminum. The guiding substrate **11**, the radiating substrate **31**, and the reflecting substrate **51** are made of dielectric materials, such as ceramic, bakelite, or styrofoam.

FIG. **2** shows the guiding unit **1** of the wideband bow tie antenna. The shape of the guiding patch **13** is at least one selected from square, circle, triangle or combination thereof. When the shape of the guiding patch **13** is square, it is able to guide horizontally polarized or vertically polarized radiation waves provided by the radiating unit **3**. This is different from the conventional Yagi antenna, wherein the guiding unit thereof is only able to enhance uni-direction corresponding to mono polarized radiation wave.

FIG. **3** jointly with FIG. **1** shows radiating unit **3** of the wideband antenna. The wideband bow tie antenna is able to correspond to polarization styles of radiation, such as single polarization, dual polarization, and circular polarization. A second bow tie radiator **35** is selected. The second bow tie radiator **35** is substantially the same as the first bow tie radiator **33**. The second bow tie radiator **35** is further coupled with the guiding patch **13** and the loop reflecting patch **53**. An angle which is formed between the direction of parallel center axis of the second bow tie radiator and the direction of parallel center axis of the first bow tie radiator is adjustable corresponding to various polarization statuses, such as in 30 degrees, 60 degrees, or 90 degrees (i.e. orthogonal). The parallel center axis of the first bow tie radiator **33** is parallel with the radiating substrate **31** and through the center line of the two signal radiating portions **37**. The parallel center axis of the second bow tie radiator **35** is also parallel with the radiating substrate **31** and through the center line of the two signal radiating portions **37**. The vertical center axis of the second bow tie radiator **35** and the vertical center axis of the first bow tie radiator **33** are overlapping or nearby corresponding to different polarization status. The vertical center axis of the first bow tie radiator **33** is perpendicular to the radiating substrate **31** and within center of the two signal radiating portions **37**. The vertical center axis of the second bow tie radiator **35** is also perpendicular to the radiating substrate **31** and within center of the two signal radiating portions **37**. Each of the single radiating portion **37** further comprises two side reflecting patches **39**, each sided patch **39** attaches the end side of each single radiating portion **37**, and the each single radiating patch **39** is adjacent to one of two end points of the each single radiating portion **37**. The shape of sided patch **39** is triangle.

If one embodiment comprises the first bow tie radiator **33** and the second bow tie radiator **35**, and the direction of parallel center axis of the second bow tie radiator **35** and the direction of parallel center axis of the first bow tie radiator **33** are orthogonal to each other, and the vertical center axis of the second bow tie radiator **35** and the vertical center axis of the first bow tie radiator **33** are overlapping, then it is able to generate dual polarization radiation wave when inputting signal to the feeding ends of the first bow tie radiator **33** and the second bow tie radiator **35**.

FIG. **4** shows the reflecting unit **5** of the wideband bow tie antenna. The shape of the loop reflecting patch **53** of the reflecting unit **5** is at least one selected from square loop, circle loop, triangle loop or combination thereof.

FIG. **5** shows effect of direction gain (dBi) of the wideband bow tie antenna caused by the reflecting unit **5** and guiding unit **1**. And each curve represents different combination status as below:

curve	Line segment	inner elements combination of the wideband bow tie antenna
A	Square node segment	comprising a guiding unit 1, a radiating unit 3, and a reflecting unit 5, wherein size of the guiding patch 13 is corresponding to half wavelength below 1.7 GHz operation frequency
B	Circle node segment	comprising a guiding unit 1, a radiating unit 3, and a reflecting unit 5, wherein size of the guiding patch 13 is corresponding to half wavelength below 2 GHz operation frequency
C	Up triangle node segment	only comprising a guiding unit 1, and a radiating unit 3
D	Down triangle node segment	only comprising a radiating unit 3, and a reflecting unit 5
F	Diamond node segment	Only comprising a radiating unit 3

Refer to FIG. **5**; it is known that when the wideband bow tie antenna only comprises the radiating unit **3**, the gain of the antenna is 2-3 dBi. Also, the effects in low-frequency gain and high-frequency gain of the wideband bow tie antenna caused by the reflecting unit **5** and the guiding unit **1** are known. According to the curve A and curve B, it is known that the size of the guiding patch **13** is configured to determine the high-frequency gain.

FIG. **6** shows the front to back ratio, F/B, of the wideband bow tie antenna caused by the reflecting unit **5** and the guiding unit **1**. The F/B represents field amplitude ratio of main lobe and back lobe. According to curves A and B, it is known that when the wideband bow tie antenna comprises radiating unit **3**, reflecting unit **5**, and guiding unit **1**, high-frequency (2.5 GHz~2.7 GHz) F/B is effectively enhanced.

FIG. **7**A shows current distribution in low-frequency (0.698 GHz~0.96 GHz) of the wideband bow tie antenna. According to the current distribution of loop reflecting patch **53**, the loop reflecting patch **53** is configured to provide reflection function of low-frequency radiation wave. FIG. **7**B shows current distribution in mid-frequency (1.71 GHz~2.45 GHz) of the wideband bow tie antenna. According to the current distribution of guiding patch **13**, the guiding patch **13** is configured to determine mid-frequency radiation characters. FIG. **7**C shows current distribution in high-frequency (2.5 GHz~2.7 GHz) of the wideband bow tie antenna. According to the uniform current distribution of guiding patch **13** and loop reflecting patch **53**, the guiding patch **13** and loop reflecting patch **53** are configured to determine high-frequency radiation characters.

FIG. **8**A shows the S parameter diagram of the wideband bow tie antenna. Within operation frequency bandwidth (698 MHz~960 MHz, 1710 MHz~2700 MHz) of Long Term

Evolution, LTE, the reflecting loss parameter (S**11**, diamond node curve) of the first bow tie radiator **33** and the reflecting loss parameter (S**22**, circle node curve) of the second bow tie radiator **35** are both smaller than −10 dB. And the isolation parameter (S**21**, up triangle node curve) between the first bow tie radiator **33** and the second bow tie radiator **35** is as below: smaller than −15 dB in low-frequency (0.698 GHz~0.960 GHz), smaller than −11 dB in mid-frequency (1.71 GHz~2.45 GHz), and smaller than −20 dB in high-frequency (2.5 GHz~2.7 GHz). The aforementioned S parameters meet regulations of antenna operation.

FIG. **8**B shows gains of horizontal polarization and vertical polarization of the wideband bow tie antenna. The up triangle node curve represents horizontal polarization, and the down triangle node curve represents vertical polarization. Refer to FIG. **8**B; it is known that the gain of the wideband bow tie antenna is above 6 dBi in all designated frequencies.

FIG. **8**C shows 2D radiation diagram of the wideband bow tie antenna of the present invention (default frequency is 698 MHz). Square node curve represents radiation field of XZ-plane, circle node curve represents radiation field of YZ-plane. FIG. **8**D shows the F/B diagram of the wideband bow tie antenna of the present invention. The F/B is above 7 dB in both low-frequency (0.698 GHz~0.96 GHz) and high-frequency (2.5 GHz~2.7 GHz).

The above disclosure is related to the detailed technical contents and inventive features thereof. People skilled in this field may proceed with a variety of modifications and replacements based on the disclosures and suggestions of the invention as described without departing from the characteristics thereof. Nevertheless, although such modifications and replacements are not fully disclosed in the above descriptions, they have substantially been covered in the following claims as appended.

What is claimed is:

1. A wideband bow tie antenna, comprising:

a guiding unit, comprising:

a guiding substrate;

a square guiding patch, configured on a plane of the guiding substrate;

a radiating unit, adjacent to the guiding unit, the radiating unit further comprising:

a radiating substrate;

a first bow tie radiator, configured on a first plane of the radiating substrate, the first bow tie radiator further coupled to the guiding patch, the first bow tie radiator further comprising two single radiating portions which are symmetrically configured to each other, the width of each single radiating portion increasing from a feeding end of the bow tie radiating portion to an end of the each single radiating portion;

a second bow tie radiator, substantially the same as the first bow tie radiator and configured on a second plane opposite to the first plane of the radiating substrate;

a reflecting unit, adjacent to the radiating unit, the radiating unit further configured between the guiding unit and the reflecting unit, the reflecting unit further comprising:

a reflecting substrate;

a loop reflecting patch, configured on a plane of the reflecting substrate, the loop reflecting patch further coupled with the first bow tie radiator,

wherein the second bow tie radiator further coupled with the square guiding patch and the loop reflecting patch,

wherein a direction of a parallel center axis of the second bow tie radiator and a direction of a parallel center axis of the first bow tie radiator are orthogonal to each other, and

wherein a vertical center axis of the second bow tie radiator and a vertical center axis of the first bow tie radiator are overlapping.

2. The wideband bow tie antenna as claimed in claim **1**, wherein the shape of the guiding patch is selected from square, circle, triangle or combination thereof.

3. The wideband bow tie antenna as claimed in claim **1**, wherein the shape of the loop reflecting patch is selected from square loop, circle loop, triangle loop or combination thereof.

4. The wideband bow tie antenna as claimed in claim **1**, wherein the each single radiating portion further comprises two sided patches, one side of the each sided patch attaching end side of the each single portion, the each sided radiating patch adjacent to one of two end points of the each single radiating portion.

5. The wideband bow tie antenna as claimed in claim **4**, wherein the shape of the two sided patches are triangle.

* * * * *